Design and Development of Social Artificial Cognitive Agent for Effective Teaching

A Synopsis submitted

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Atul Prakash Prajapati

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Chapter 1

Introduction

1.1 Introduction

In this synopsis, the proposed research work is to design and build social artificial cognitive agents for effective teaching in education system. The cognitive agents can self manage and interact with other agents in an artificial society having harmonized teaching values and strategies based on individual knowledge and experience as performed by teachers in educational system. Teaching system is collective group of teachers that help students promptly with best methodology on any query. The teacher reacts on the basis of deep knowledge and teaching pedagogy to reach the solution that satisfies the student quench. For certain specialized queries, the teachers with dedicated teamwork and skills of each individual peers complete the errands. The errand whether it is in the interest of an individual teacher or for teaching pedagogy requires deep acquaintance about the subject. The absolute acquaintance is managed by the artificial cognitive society for its smooth function.

So by taking all these constraints in concern, this synopsis presents a solution that uses real time approaches (individual cognitive agents, knowledge base system, and cognitive agents society) that will act as teaching pedagogy.

The main purpose of this research is to develop an artificial cognitive agents society, which will share a common knowledge base, (as well as they will have their own individual knowledge base also). Common knowledge base will make them to act as a social agents. Knowledge base is something action oriented, that is far more superior to database. This knowledge base is necessary to make cognitive agent intelligent for dispensation of the

information, further by using this knowledge base agents can make appropriate decisions in the real time environment. This task will be achieved by developing a structural design that will include hardware and software combination. By using these structural design, agents itself shall be able to give the decision or they may communicate to each other by using common knowledge base for providing the required information.

1.2 Motivation

Motivation behind this synopsis is to develop an artificial cognitive agent for effective teaching. This structure aims to improve basic flaws present in teaching pedagogy. The teachers are human beings, and every human being have their own physical limitations. They suffers with lots of problems (odd weather conditions, ageing effect, egoism, favouritism, biased aptitude, knowledge update, individual capability of explaining things through drawing diagrams flowcharts, feels inferior to learn from others etc.). Also Human teachers cannot teach continuously for a long period of time, this degrades the efficiency, and affects the teacher's performance. Sometimes teachers require additional support, like animation, a picture or video of a particular thing to make students understand about the context. Because audio and visual tools help the students for quick and prolonged memory retention (Suppose someone is teaching the working of D.C Motors, and if one's shows the picture/video of D.C. motor to the students. This may help to the students, to make clear understanding about the subject). For this additional time is required to arrange the audio video appliances. But one can deploy audio visual tools in the humanoid. Also humanoids are unbiased, can update knowledge base, no ego problem, never feel inferior to learn things from human teachers. As humanoid is a combination of hardware and software. It can work continuously for a long period of time without reducing its efficiency. Also odd weather conditions can not affect it's performance. The important thing is, this humanoid is a cognitive agent, that means it is not only a machine, but it is an intelligent agent also. This synopsis talks about the humanoid agent's society (a group of individual cognitive agents). When they work collectively (as human teachers do) for solving any specific query will definitely come across with better solutions. It is well known that individual consciousness (cognitive agent's knowledge base) is not sufficient for solving any specific problem. But when they approach for collective consciousness, they usually come

across with a better solution.

Now a days the systems that are working in this area, follows following approaches.

- Sound based recognition approach.
- video based recognition approach.

But these approaches are not individually enough for recognition purpose. The sound based recognition approach suffers with environmental noise problem. Which creates problem in recognizing the objects. On the other hand in visual based recognition, it is not able to recognize objects in low light conditions (Fuzzy images, bad weather, overlapping etc.).

Hence this synopsis proposes to combine all the approaches (audio, video, sensory data, cognitive agent, agent's society, and knowledge-base) into one module to solve the basic problems present in the pedagogy. Using above information the features are extracted and based on feature set the best optimal results can be obtained.

1.3 Literature Review

1.3.1 Different cognitive and expert systems for assisting and improving teaching pedagogy

Lots of expert/intelligent systems have developed for improving the quality of teaching or providing assistance to the teachers. Following are some expert/intelligent systems that has been designed in this area. In 1979, Tim o' shea [She79] had proposed a self improving teaching system. For this tim proposed that, there should be alternative computer programs present within your computer. In 1983, Derek H. Sleeman [Sle83] presented a computer aided intelligent model. In this model the author explained the rules of algebra. The approach that was followed to design this model was, initially some wrong rules of algebra was stored in the database. Then this model provides the correct way to represent these rules. In 1984, Gerhard et al. [GF84] proposed an on-line help system for solving particular problems, in this the online tutor would guide to the students about the failure and usage of complex computer system. Further in 1984, williom et al. [WFC84] proposed a debugging program for prolog language. In 1986, Pat langley et al. [PL86] proposed learning concept for reactive environments, the aim was to design a system that can learn

in a reactive environment. Further in 1986, Nigan Bayazit [Bay86] proposed an interactive model that is used in computer aided designing, this model was designed for teaching CAD systems in Istanbul Technical University. It contains two modules one is for the students and another one is for the teachers. Further in 1986, Massimo Gallanti et al. [MG86] explained the benefits of expert aid systems. This paper presents a case study of a thermal power plant, where an expert aid system were deployed, to check the pollution level of the water cycles. In 1987, R. S. Perez et al. [RP87] presented a general report on computer based expert system (CBI) for military training. They explained the benefit of such expert systems, as these are cost effective and easy to handle. In 1987, W. Feurzeig [W.F87] presented a comparative study in between the Traditional tutoring systems (CAI) and intelligent computer aided systems (ICAI). Further in 1987, Emrah Orhun [Orh87] Proposed the benefits of expert tutoring systems. It showed that, people uses to call personal tutors to teach their children. As the personal tutor can pay more attention to their children. But this way of teaching is not cost effective. As a solution they can deploy an expert tutoring system for this purpose. In 1987, J. G. Neal et al. [J.G87] proposed a rule based natural language processing tool. For inferencing and reasoning, it uses rules that had been defined in its knowledge base. Further in 1987, L. H. Nawrocki [L.H87] proposed a case study of joint military and engineering project by providing an intelligent computer aided prototype model ICAI. Further in 1987, A. Brebner et al. [A.B87] proposed the role of multimedia approach in instruction based computer tutor. Further in 1987, E. Dmc. Williams et al. [E.D87] presented a model, that consist of two sections. First section describes the CBI (Computer based instruction system) for Navy sponsored research work and development, where the basic target was to provide some intelligence to the CBI system. This system was used to train military people. In second part it described the benefit of adding intelligence in CBI system. Further in 1987, Kazuhisa Kawai et al. [KK87] proposed a model having three modules, 1) The expertise module 2) The student module 3) Tutoring strategies. In this paper the emphasis was given on student module section. This section describes the behaviour of the student, whether they are getting the contents or not. In this module they proposed the inductive inferencing approach for students. All modules were designed using Prolog language. Further in 1987, David G. Ullman et al. [DGU87] presented a case study in the field of mechanical engineering. They had explained the complexity level in designing the complex systems. As a solution

to this problem, they proposed a record and play based knowledge-based model. That records the expert's verbalization while designing the complex systems. In 1988, Joachim Wedekind [Wed88] presented a model for learning simulation and modelling process with the help of an expert system. Further in 1988, D. Partridge. K. Paap [DP88] Presented the comparative study in between symbolic and sub-symbolic approach for modelling learning process in an expert system. In 1988, Randall et al. [RW88] defined that, the definition that is used to define expert systems is not appropriate. Rather it is ill defined. They focused on the factors that influences an expert system. They suggested that, the expert system should be defined by its characteristics, rather by using the common definitions. In 1988, Dario [Giu88] defined the role of LISP language in developing expert systems. He explained that LISP provides the fastest way for construction of an expert system. The paper also deals a case study in which a Chinese tutoring system was designed in less than 3 weeks. In 1989, Nakhoon et al. [NK89] developed an ITS for medical students. Further in 1989, Joel et al. [JAM89] presented a psysiology tutor to assist the students. This tutor uses rule based approach and was implemented in turbo-prolog language. In 1989, Mohammed et al. [MMH89] designed an authoring program named (TRAS). This model has two sections, first section is basically designed for teachers, in which teachers design the rules. Once the designing is complete these rules can be converted in to PRO-LOG language by TPT module. In 1989, Marilun et al. [ML89] designed an intelligent tutor. This could be used for graphical representation of quadratic equations. Further in 1989, Michael [Bee89] designed an expert system for learning mathematics (basic algebra, trigonometry, and calculus) rules. In 1989, Janis et al. [JAB89] explained the concept of knowledge-base management system. They explained the practical aspects of knowledge-base and how it should be designed for better inferencing. In 1989, Ali Farghaly [Far89] presented a paper. In which he suggested that an expert system should be designed as natural language processing system, so that learners may fell it more interactive. He also proposed a model (MICALI), that was highly interactive. Further in 1990, Parvati Rajan et al. [PR90] designed a tutor for teaching trigonometry concepts to the students. In 1990 Gilles et al. [GI90] developed a framework for ITS, that teaches word processing to the beginners. In 1990, A. Benslimane et al. [AB90] proposed an expert system, that was primarily concerned on teaching. Besides this it was able to show teaching plan to the students. In 1990, Daniel M. Russle [Rus90] presented a model "Alexandria". This

model works as a data-base, that stores the historical events occurred around third century B.C. This model was very useful for the scholars who want to study the historical events. Further in 1991, Yoon Heelee et al. [YHL91] designed an expert tutoring system for medical students. It was able to correct the spelling mistakes by providing help (Missing characters, Order reversal etc.). In 1991, H. Kindler et al. [HK91] had proposed an knowledge based architecture, for the assistance of accidentally irradiated person. In 1991, M. Quafafou et al. [MQ91] proposed a simulator based ITS, for the students related with mining field. This model was developed in C++ language. It provides the different simulation aspects of mining to the students. Further in 1991, Luigia et al. [LCA91] had proposed a multi-agent framework and agent based knowledge for ITS systems. They used first order predicate calculus for reasoning and referencing. In 1992, Albert et al. [ATC92] designed an ACT tutor. This is programming tutor having a set of rules to teach the students. A student can learn basic programming concepts and can also check their performance by using these rules defined in an ITS. In 1992, Eric [Gut92] proposed a SIFT tutor (self improving fractions tutor). In this paper he explained that SIFT is a self improving tutor. It can interact with the students and it use to learn these interactions. In 1992, Jean et al. [JM92] presented a paper in which they explained a tutoring system named GRACE, developed by the NYNEX science and technology. This tutor helps in learning COBOL to the beginners as well as to the experts also. In 1992, Rose [RWC92] proposed a GT-VITA tutor (Georgia tech visual inspectable tutor and assistant). This provides help to the beginners in designing the complex systems. In 1992, Henry et al. [HH92] proposed FLUENT project for learning foreign languages. In 1993, Haider et al. [HR93] proposed a programming tutor. It provides sample programs for the problems, so that students can understand the basic concept and can solve the problem. In 1993, Vijay et al. [VV93] proposed a simulator model Turbina-Vyasa. It was designed for the trainees in marine power plant. Turbinia was a computer tutor that teaches trouble shooting by using simulator. In 1993, R. Macura et al. [RM93] proposed a database model that uses past cases (case based reasoning) for inferencing. This program was designed on an apple macintosh o.s. to teach radiology diagnosis. In 1993, M. Joao [Lou93] proposed a learning model LABEL, for teaching concepts of electrical circuit. In 1993, Mohamed et al. [MQ93] proposed a concept in which fuzzy logic and genetic algorithms was combined, for making efficient tutoring system. In 1994, Robert et al. [RDT94] proposed an ISD based system devel-

opment approach. This instructional system development approach can improve learning and will be helpful for system developers. In 1994, Kenneth [Tai94] proposed a simulation based model for learning multimedia applications. He also pointed out the drawbacks of the models developed for teaching multimedia applications. In 1995, Robert [Ten95] described the fourth generation ISD system. In 1995, Jeroen et al. [JJGvM95] proposed a Fuzzy based instructional model FLIM's, for modelling knowledge-base. It was used in an ITS system CASCO. In 1995, Valerie [Shu95] proposed a model SMART embedded with an ITS tutor Stat-Lady. In 1996, Michael et al. [MS96] presented a software tool. It was able to create tutorials and graphical representation of objects. In 1996, Jon et al. [JAE96] proposed a new way of designing knowledge base for ITS systems. He used case based reasoning approach for the self improvement of ITS systems. In 1996, Chee-kit et al. [CKL96] proposed a model Word-math for the students of age group 9-12 of Singapore primary school, for teaching basic word concepts. In 1997, Susan Bull [Bul97] proposed foreign language tutor system. It was able to generates feed back reports. In 1998, Mary et al. [MAM98] proposed a PAT tutor, to teach algebra concepts. Further in 2000, Albert [AC00] developed a modelling tool for real world problems by algebraic reasoning, but was not a successful tool as mentioned in requirements. In 2000, Rajaram et al. [RG00] proposed an animated agent ADELE, for intelligent tutoring. This agent uses a bayesian network based knowledge-base. It draws the relationship between symptoms and disease and guide a student by multiple choice questions. In 2000, A. bigail et al. [ASG00] developed an ITS ANDES for teaching introductory physics. Further in 2002, Declan [DK02] developed an ITS EDUCE. IN 2002, Amruth [Kum02] designed a web based ITS, for teaching and debugging C++ programs. In 2002, Leanna et al. [LL02] presented an ITA, for teaching propositional rules. In 2003, Ana et al. developed an authoring tool for helping the teachers in designing teaching learning systems. In 2003, Albena et al. [AS03] developed a CG-EST self tutoring system. In 2004, Emanuela et al. [EM04a] presented an augmentation technique, that takes an essay as an input and try to augment missing parts (prepositions etc.). In 2004, Eva et al. [EM04b] proposed a web based tutor for teaching linear programming concepts. In 2005, Nilufar et al. [NB05] developed an ITS for teaching UML class diagrams. In 2005, Carbolina et al. [CG05] proposed a multi agent based ITS, that uses case based reasoning technique for performing inferencing. In 2007, Xin et al. [XL07] proposed a case study in which he explained that the expert tutoring system are

superior to non-expert systems. Further in 2007, Yaser et al. [YN07] developed an open ITS Bit-tutor. In 2010, Philippe [PFV10] had stated that, the definitions used for defining ITS are not appropriate, for properly defining the ITS, he suggested hybrid approach designing technique. In 2010, Noboru [NM10] developed an on-line teaching tutor. In 2011, Candice et al. [CA11] developed web based application for teaching chemistry principles. In 2012, Gagan et al. [GG12] proposed the concept of fuzzy modelling in designing ITS systems. In 2013, Xu Daomin [Dao13] explained the importance of e-learning approach in the current era of growing computer field. This paper presented a multi-agent based e-learning system to teach individual students. In 2013, Ivanova. M [Iva13] presented the idea of facial expression and gesture recognition methods. It can improve the quality of teaching by applying above methods to any intelligent tutoring system. In 2014, Steif et al. [Ste14] presented a cognitive tutor approach for solving assignment checking problem. Nowadays in engineering institutions, assignment checking is a very time consuming process. Students have to wait for a long period of time for their assignments to check whether their answers was right or not. As a solution to this problem, a cognitive tutor provides alternative solutions to any particular problem. Now students can consult to the cognitive tutor to check their answers. In 2014, Malick et al. [Mal14] presented a game tutor that uses Blender (a free and open source for 3D animation suite), for teaching the skills to play a carrom game. This paper also presented a comparative study with another famous carrom game "carrom king". In 2014, Abbas. M. A. Ahmad et al. [Abb14] presented a solution to the problems of conventional teaching method "book and worksheet practice". It states that teachers use to teach in a traditional manner, by using books, and writing books is a very tedious task. It requires a lot of time and hard work. It is the generalized way of teaching. Someone had written books years back, and students are still learning from them. As a solution, this paper presents an intelligent tutoring system. It uses a web technology approach for finding the subject contents. Further in 2014, Chrysafiadi et al. [Chr14] presented a programming tutor system that accepts a set KEMCs (Knowledge error, motivation, and cognitive states). This model tries to improve the capability of those students, who wants to learn programming languages. This model uses various techniques to implement this concept such as overlay, stereotypes, fuzzy logic and OCC cognitive theory. In 2014, Bolivar Baron et al. [BB14] presented a paper that focused on the multimedia approach (audio-visual effects) for teaching students. They suggested

that, if one uses multimedia approach to teach to the students, then students can learn better than the conventional teaching method. They had compared these two teaching methods with the help of fuzzy cognitive map technology by drawing maps, and after inferencing, they had found that multimedia approach is much better than conventional teaching method. For producing isomorphism between graphs, they had used Ullman's algorithm. In 2014, Pratama et al. [Pra14] had proposed a meta-cognitive based scaffolding classifier. This approach is useful for the students. It defines 'What to Learn and How to learn'. By using a meta cognitive scaffolding classifier, a student can increase its learning capacity. Further in 2015, Corbi et al. [Cor15] presented a model "LIME" to a PSLC cognitive tutor. That has an analytical database. Here cognitive computer tutor had provided by the Pittsburg Science Learning center, and Carnegie Mallon University had provided intelligent and visual interactive activities. They had used XML database for keeping the records. The basic target to build this project was to record the interactive sessions with the students, and with the help of cognitive tutor perform inferencing, then find out some key points to improve the student's academic performance. In 2015, Ugur.E.Nagai et. al. [Ugu15] presented the robotic approach for building an intelligent system. They explained the concept by taking the examples of infants, how do they start learning new things? Similarly, if we make a robot that collects good quality data (sensory data) by analysing the elements (feature extraction approach), then one will be able to design a good quality knowledge base , that can be used for the generation of good quality results .

1.3.2 History of machine learning (Artificial Intelligence) and cognitive science

As it is mentioned that to meet the objectives defined in this thesis, there will be a need of a cognitive architecture. So this section of thesis describes different cognitive architectures that has been developed yet and about the basic qualities and prerequisite that a cognitive architecture should have.

In this era of machine learning, artificial intelligence plays an important role. Artificial intelligence is based on the assumption that human thinking procedure can be mechanized. It is an area of computer science, which tells that "how a machine can be made intelligent". In early days researchers used to face a great difficulty in maintaining his research work.

They cannot carry tons of book with them everywhere. If they want to study the current development in their research area. Either they have to travel a lot or have to pay a lot in bringing the documents from one place to another. So in 1945, Vannevar Bush [Bus45] proposed a solution for this problem. In this article bush proposed a mechanical system called "memex", a disk less device using improved microfilm. This device has the capacity of holding all the books, information, pictures and relevant information. Further in October 1950, A.M.Turing explained machine learning concept [Tur50]. In this article he proposed that, how can it be proved that a machine can behave like a human? For this he called an interviewer who was sitting in a room and two persons were sitting in adjacent room, and both parties talked by teleprinter communication. Interviewer asked the question and interviewees have to answer the question. But if we replace one person by a machine, then it will be difficult to decide whether the answer was given by the machine or by the person. Further in 1959, Strachey [Str52], proposed that, one can implement machine learning concept by logical programming. For this he gave the concept that in a typical mathematical problem most of the instructions are non mathematical, and one has to spend much of its time in preparing non mathematical portion of the program. But the actual mathematical portion of the program is of relevance, which implements the logical part of the problem. A.L.Samuel in 1959, [Sam59] proposed a game "Game Of Checkers". This was the checkers game rather than chess game. Samual had chosen checkers in place of chess, because of its simple rules. These rules primarily focus on learning techniques. To play this game one has to first design rules by using machine learning concepts. This type of learning technique was first designed by Shannon's in the game of chess in 1950. The machine learning programming used in these games was similar to the one that was used by Strachey in 1952 [Str52]. This amazing field of machine learning named Artificial intelligence was founded in a conference at campus of Dartmouth college in the summer of 1956 [JMCS].

A lot of research is going on in the field of effective learning. But even after 50 years of research, researchers have to face a great difficulty in implementing these learning techniques. Learning techniques are difficult to implement. It requires a large set of training data. It faces a great difficulty in learning by a human teachers. So a simple concept comes into mind that an intelligent machine is not enough. We are in need of a machine that can learn, can make itself intelligent and can implement that knowledge

whenever required. Now the question comes into mind, can a cognitive machine is able to fulfil our requirements? To answer this question we have to study about the cognitive architecture. How does it work? There are three approaches to build a cognitive system:

- Cognitivist Approach
- Emergent Approach
- Hybrid Approach.

1.3.3 Cognitivist approach and its architecture

The basic concept of cognitive science is in recognition, and recognition comes from the learning. Any cognitive architecture should have some memory element (called its knowledge base). Typically any cognitive architecture has two types of memory, first one is short term memory and another one is long term memory [JEL09]. This memory element gives the cognition power and decision making capability to the agent. This also decides, how intelligent your agent is (or how accurately it can recognize the objects and events). Memory element is not the part of any typical architecture. As memories can change over time [Min67]. So one should not consider agent's knowledge as permanent or part of architecture. It is analogous to the building example. As a building have some permanent features like its foundation, roof and rooms. These can be included in its architecture. But we should not include furniture doors in its architecture. Architecture is something that is permanent in nature. Memory gives the power of cognition, besides this the agent should be flexible also. As it learns something new, or if existing knowledge need to be modified. It should be ready to adapt that changes. Cognitive architecture is antithesis of expert systems, which defines a narrow aspect of system intelligence. Although it is intelligent enough to take decisions, but it is application specific, rather specialized. In contrast cognitive system has a deep knowledge. It works at the system level rather at component level that is designed for specialized task. Newell (1973) had proposed system level research for cognitive systems. In 1959 Allen Newell had developed a system (GPS) for solving general problems [ANS59]. R. C. Schank and R. P. Abelson proposed the concept of scripts [SA77] in 1977. Then J.Mc.Carthy in 1960, [Car60] had proposed a programming language known as LISP. A program ELLIZA [Wei66] came into existence In 1966 . Which relates the machine learning process to neural networks. Now a day's

every sector, whether it is railway, banking, stock market demands an intelligent system, that can inference itself based on certain circumstances. They do not want existing system upgrade, and this requirement can be fulfilled by the cognitive systems only. In any typical cognitive architecture memory element is used for learning the agent. For a human level cognition learning should be adaptive in nature. One can categorise the learning in three categories, perceptual learning, episodic learning, procedural learning [JEL09].

- Perceptual Learning: (learning new objects) builds perceptual associative memory of an agent. This is based on perception. Whatever one perceive from external environment, stores that in the knowledge base. Based on that knowledge, one can inference some result and decides that, what action should be performed .
- Episodic Learning: based on previous experiences one use to recall the things. This is something taken from the consciousness. There are two types of episodic memory exist.
    1. Transient Episodic Memory: for short term retention.
    2. Declarative Memory: for long term storage.
- Procedural Learning: (Learning of new actions) as the name implies, it is procedural in nature. It perceive something from the environment then it checks it. Whether it is known object or new one. If known then no problem, otherwise it memorises the things.

Cognitivist approach (Symbolic approach) is basically a rule based approach. Here one has to provide rules (Propositional rules) and based on these rules. It does inferencing to produce the results. For training the agent it uses frames and scripts method [SA77]. This is based on hard coded logic concept (predefined set of rules not adaptive in nature). In cognitivist based approach embodiment is not required. In this approach one has to train one's agent in abstraction. This is the basic drawback, that is present in cognitivist approach. In this approach agent should have human like recognition capability. For this it is necessary to train the agent in real world environment, as humans learn. The learning, that is done in abstraction is not applicable in real world environment. Allen Newell [[ANS59], [NS72], [NS76], [New90]], H.A.Simon [NS76], J.Mc.Carthy [[Car60], [JMCS]] had done a lots of work in this area. There are many expert systems exist in cognitivist approach like ELIZA in 1966 [Wei66].

1.3.4 Emergent approach and its architecture

In 1988, J. A. Fodor and W. Pylyshyn [FP88] had Listed out the difference in between cognitive architecture and normal architecture. In 1982, J. A. Feldman and D. H. Ballard described the difference between two approaches (Symbolic and Sub-symbolic). They stated that sub-symbolic approach is much better than symbolic approach [FB82]. Cognitivist approach (Symbolic approach) is basically a rule based approach [MP43], and uses to train the agent in abstraction. There is another approach for implementing cognitive architecture, that is called Emergent approach (Sub symbolic). This follows general state based approach. As in symbolic approach one uses prepositional logic to represent the relation antithesis to this sub symbolic approach uses state relations. It represents objects by states and state relation to show the transition in between states. It converts state relation into weighted state system for inferencing. In 1958 F. Rosenblatt [Ros58] had proposed a model. This model explains the concept of Perceptrons, that follows neural network based approach. In 1969 [MP69] M. Minsky and S. Papert had proposed, that perceptons can be useful in the solution of learning problem. Further S. Grossberg in 1976 [Gro76] had proved perceptron theory. In 1981 [McC81] J. L. McClelland had proposed a solution for memory retrieval problem. Further in 1981 T. Kohenen [Koh82] had proposed a learning process that is self organized and uses a neural network approach.

Connectionest approach

This subsymbolic approach [Smo87a] is a general neural based approach. It is based on training set method. Here one has to train its agent by providing training sets. This is also a hard coded logic approach. The agent is trained for input and output matching, for that one has to provide training sets. Training is done in abstraction.

Enactive approach

H. R. Maturana founded the base of Enactive systems [Mat70]. Maturana and F. J. Varela gave the definition of Enactive approach [[MV80] , [MV87]]. Further R. A. Brooks [[Bro91] , [Bro99]] developed robots based on this approach, which have the reasoning capability like humans. This approach is the best in among of all other approaches. As this fulfils all the commitments that is expected by any cognitive architecture. The approaches

that has been discussed yet do not provide human like learning methods, because humans learn in the real world environment. But these approaches use to train their agents in abstraction. That uses hard coded logic format for providing learning set. An enactive system should has following features.

- Autonomous System: Cognitive System have their own architecture their own knowledge base. They work autonomously. They learn from the real environment and produces results after inferencing.
- Adaptive in nature (not hard coded): The basic definition of Artificial Intelligence, defines that cognitive system should behave like a human agent (and they are adaptive in nature). They learn new things and if required modify their existing beliefs.
- Sense making: Sense making capability comes from the reasoning capability, and reasoning capability comes from the learning. So learning plays a vital role in any cognitive architecture. Learning is the ability that gives the power of recognition and decision making capability. To retain learning knowledge base is used in cognitive architecture.
- Requires embodiment : Embodiment is required so that the agent can learn in the real world environment. For this, one needs a humanoid like system.
- Experience: Cognitive agent is expected to behave like human agent, and human agents learn in the real world. So cognitive agent should get experience about the environment by learning in out side world (real time approach). If it learns socially, it is called social cognitive agent. Social cognitive agents are far more superior to those agents which learn in abstraction.

It uses machine learning template matching and feature mapping approaches, which makes this approach robust and versatile.

Dynamical approach

Dynamical approach is a causal loop system. It is based on cause and effect approach. It uses hard coded logic method to train its agent. Cera cranium architecture is one of the among that implements dynamical approach.

1.3.5 Hybrid approach and architecture

Hybrid approach is the combination of the two approaches. It covers both symbolic and sub symbolic approaches. P. Smolensky proposed a model [Smo87b], that implements this architecture. Similarly many other scientists proposed various models [[AL98] , [Sun95], [Sun94]]. Clarion architecture [Sun07] is one of among that implements this approach.

1.4 Cognitive Systems

To be a cognitive system only few abilities like recognition and decision making is required. But to achieve human level cognition, it should have additional set of capabilities. Here are some features that a cognitive system should have.

1.4.1 Recognition and categorization capability

Recognizing anything is the most typical aspect, it should follow a proper sequence.

- Perception (first requirement is, agent should perceive something from outside world).
- Feature extraction.
- Inferencing.
- Categorization and Learning (differentiate in between learned objects and new one, and learn the new one).
- Action.

1.4.2 Decision making capability

This is directly proportional to the learning. After learning only agent can decide, which alternative is good among available alternatives.

1.4.3 Perception and situation assessment capability

Agent should be able to correctly perceive objects from the external environment. It should be focused to its object, as external noise plays a destructive role in perceiving something. So it should have a strong sensory data collection method to perceive something.

1.4.4 Prediction and monitoring capability

This is a something similar to human level intelligence. As a good driver can predict that after few kilo meters, his car will be in need of fuel. This type of ability can be achieved by strong monitoring mechanism only.

1.4.5 Reasoning capability

Cognitive agent should have reasoning ability for producing more accurate results. For achieving reasoning capability, it should be able to establish relationships between the stored data in its knowledge base. It can use techniques like first order logic, production rules, neural networks for establishing relationship in between the objects, and knowledge about the reasoning can be heuristic. This is related to the learning. By using this technique agent can make new decisions and store them in the knowledge base, or it can change previous beliefs also.

1.4.6 Interaction and communication

The cognitive agents should work in a society manner. As in a society the work is done by consulting other society members. Analogously the agents should communicate to each other for the best inferencing. Also for recognizing any object in a real word communication, memory is required. The communication in between or in among of agents may be in the form of query message, audio files, video files.

1.4.7 Learning and reflection capability

We have already discussed about types of learning for cognitive agents. To make a cognitive agent learn one has to extract object's features and store them in a proper format, that your architecture supports. Then whenever one is in need of recognizing something, system matches the extracted features with the feature set that is stored in knowledge base. This is called episodic memory concept.

1.5 Different cognitive architectures

Following are some cognitive architectures that has been developed. Prodigy, Soar, The entropy reduction engine, FORR, The AIS architecture, 3T, CIRCA, CLARION, ACT-R,

Icarus etc.

1.6 Proposed Work

The fundamental problem present in teaching pedagogy is that, teachers use conventional approaches (chalk and board medium) to teach their students. Rather than using audio-visual effects with conventional approaches. Also it has been proved that, this animated way of teaching is far more superior to the conventional way of teaching. Audio-visual effects can be think of as an additional support to make clear understanding of the subject to the students. Another problem is, a teacher is a human being, and every human being have some sort of limitations. As, he/she cannot teach for hours and hours. When a teacher teaches for a long duration, it degrades teacher's efficiency and as a result the quality of teaching degrades. Further the significant problem is, very few people are ready to teach in villages or in remote areas. But the fact is, a large portion of the Indian population lives in villages that's why a great part of the Indian population are not getting quality education and qualified teachers.

1.6.1 Problem statement

To design and develop a social, cognitive architecture based humanoid for effective and quality teaching to teach Electromagnetic concepts and remove the short falls of existing teachers and their teaching methods.

1.6.2 Scope of the thesis

This synopsis chooses a particular topic of Electromagnetic concepts, and will try to solve all the above mentioned problems. For this, it will be in need of a humanoid cognitive architecture. We can deploy these humanoids in villages or in remote locations, to solve the problems present in teaching pedagogy. In addition to this, human teachers suffer with lots of problem like ageing factor, sickness problem and many more, which will undoubtedly affect teaching. But humanoid is a machine, and a machine can teach the same lesson in different ways until the students don't understand completely. Also it can assist teachers by providing its features. This cognitive approach is an emerging field, and a right plan to solve the problems of conventional teaching.

1.6.3 Objective of the thesis

The primary problem in teaching pedagogy is the proficient teaching, audio-visual aids, and teaching in remote areas. Most often good teachers are not ready to teach in remote areas due to various problems. This thesis presents the solution for these problems.

1. To study the cognitive architecture for developing a knowledge-based teaching expert system in order to solve problems in conventional pedagogy.

2. To design a cognitive expert agent system for teaching Electromagnetic concepts effectively.

3. To develop a NLP (Natural Language Processing) based embedded system for achieving all validations and fulfilling all the constraints mentioned in the requirement document.

1.6.4 Methodology

This thesis presents the solution for the problems that are revealed above, by providing assistance to the teachers. For this an architecture will be developed. As this is a cognitive architecture, a knowledge base will be required. Knowledge base gives the reasoning and thinking capability to the cognitive agent. This synopsis also includes the word society (a group of cognitive agents). These agents will have their individual knowledge base and a common knowledge base (shared by all the agents). Shared knowledge base gives the power to the agents to work in a society manner. As teachers do in the real world environment. Finally all the constraints have been taken into consideration. This synopsis presents the logical step by step method to develop the project by using proper validation and testing, to meet the requirement of the project. Figure 1.1, represents the schematic diagram of the methodology used by the agent. In this, the cognitive agent will perceive things from the environment, extract the features and store them in a formatted set in the knowledge-base. When ever it has to recognize the object. It will match the extracted feature set with the existing set of features stored in the knowledge-base (if required it may consult to other agents in the society). Then after inferencing it can perform the required actions.

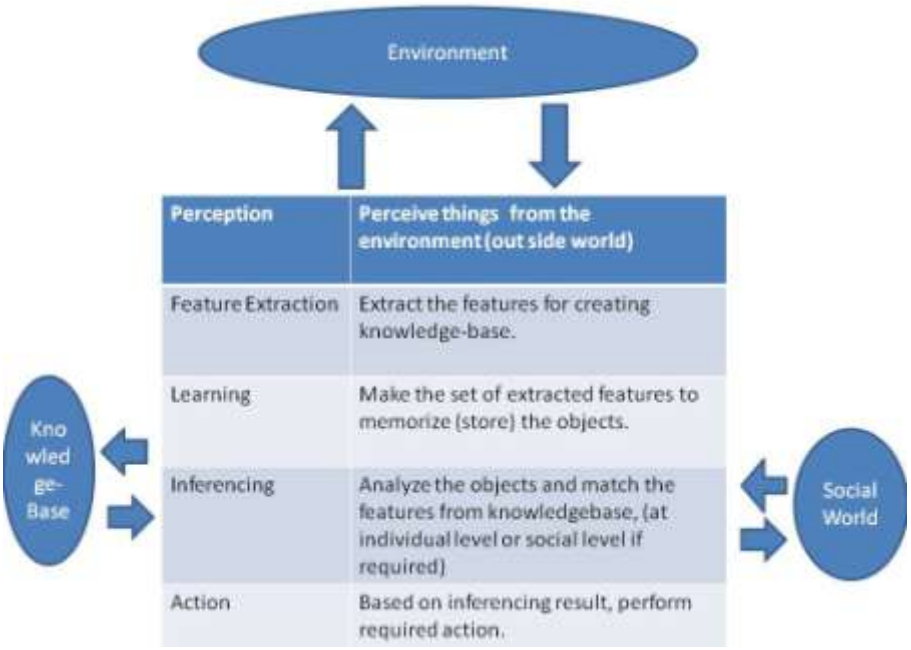
Environment
Perception
Perceive things from the environment (out side world)
Feature Extraction
Extract the features for creating knowledge-base.
Learning
Make the set of extracted features to memorize (store) the objects.
Inferencing
Analyze the objects and match the features from knowledgebase, (at individual level or social level if required)
Action
Based on inferencing result, perform required action.
Kno wled ge-Base
Social World

Figure 1.1: Schematic diagram of working of social cognitive agent.

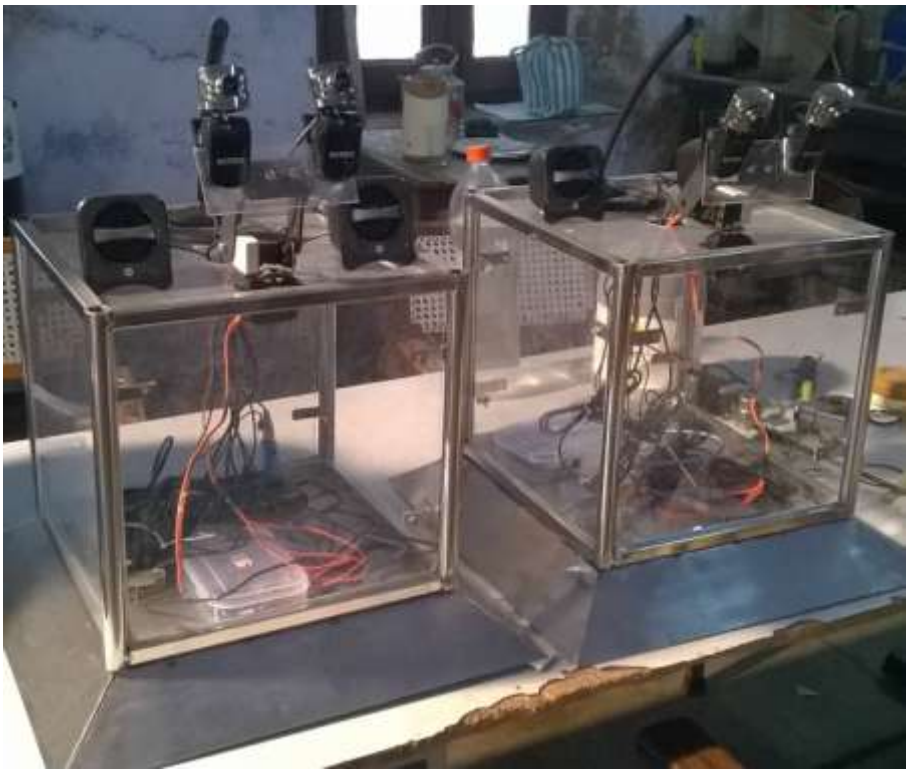

Figure 1.2: Hardware Picture of the social cognitive agent.

1.6.5 Thesis outline (Tentative)

The tentative thesis work may be divided as:

- Chapter one is the introduction. It covers the primary motive to select this project, and about the problems present is teaching pedagogy. It also describes the problem statement, various objectives and systematic procedure for the development of social cognitive agent.
- Chapter two includes the literature review. It describes history of machine learning, cognitive science, and the approaches to build a cognitive architecture. This section also discuss about the different expert and intelligent tutoring systems that has been developed for the improvement of teaching pedagogy.
- Chapter three describes the design and development of architecture of social cognitive agent for effective teaching.
- Chapter four deals with the application of above developed social cognitive agent to teach electromagnetic concepts.
- Chapter five concludes the work done in this thesis.

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